

AMENDMENTS TO THE CLAIMS

Please amend the claims as indicated:

1 21. (previously presented) A method of petrophysical evaluation of an earth formation
2 using a logging tool conveyed in a borehole in said formation, the method
3 comprising:

4 (a) obtaining values of a horizontal and vertical resistivity of said earth
5 formation using said logging tool; and

6 (b) determining a horizontal and vertical permeability of said earth formation
7 using said horizontal and vertical resistivities, said horizontal and vertical
8 permeabilities having a ratio different from a ratio of said vertical and
9 horizontal resistivities.
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1 22. (previously presented) The method of claim 21 wherein said earth formation
2 comprises a sand component and a shale component.
3

1 23. (previously presented) The method of claim 21 wherein determining said
2 horizontal and vertical permeabilities further comprises determining a water
3 content of said formation from said horizontal and vertical resistivities.
4

1 24. (previously presented) The method of claim 23 wherein determining said
2 horizontal and vertical permeabilities further comprises determining an estimate

3 of bulk irreducible water content of the formation from NMR measurements.

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1 25. (currently amended) The method of claim 23 wherein determining said water
2 content of said formation further comprises:

3 (i) inverting said values of horizontal and vertical resistivities of the
4 formation using a petrophysical model to give a first estimate of fractional
5 volume of laminated shale in the formation;

6 (ii) obtaining measurements of density and/or neutron porosity of the
7 formation and using a volumetric model for deriving therefrom a second
8 estimate of fractional volume of laminated shale; and

9 (iii) ~~if said second estimate of fractional shale volume is greater than said first~~
10 ~~estimate of fractional shale volume~~, inverting said horizontal and vertical
11 resistivities using a petrophysical model including said second estimate of
12 fractional shale volume and obtaining therefrom a water content of the
13 formation.

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1 26. (previously presented) The method of claim 21 further comprising determining a
2 vertical and horizontal resistivity of an anisotropic sand component of the
3 formation, and determining therefrom and from at least one additional
4 measurement selected from the group consisting of: (i) NMR measurements of the
5 formation, and, (ii) a bulk permeability of the sand component, a parameter of
6 interest of a coarse and a fine grain portion of the sand component.

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1 27. (previously presented) The method of claim 21 further comprising using a
2 transverse induction logging tool for obtaining said values of horizontal and
3 vertical resistivities of the formation.

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1 28. (previously presented) The method of claim 21 further comprising using an
2 induction logging tool for obtaining said values of horizontal resistivities and a
3 focused current logging tool for obtaining said values of vertical resistivities

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1 29. (previously presented) The method of claim 25 wherein using said volumetric
2 model further comprises using at least one of: (i) the Thomas-Stieber model, and,
3 (ii) the Waxman-Smits model.

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1 30. (currently amended) The method of claim 21 ~~wherein~~ further comprising
2 determining a parameter of interest ~~is selected~~ selected from the group consisting
3 of: (A) a fractional volume of said coarse grain component, (B) a fractional
4 volume of said fine grain component, (C) a water saturation of said coarse grain
5 component, (D) a water saturation of said fine grain component, (E) a
6 permeability of said coarse grain component, and, (F) a permeability of said fine
7 grain component.

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1 31. (previously presented) The method of claim 26 wherein the at least one additional

2 measurement comprises an NMR measurement, and deriving the parameter of
3 interest further comprises deriving a distribution of relaxation times from said
4 NMR measurements and obtaining therefrom a distribution of components of said
5 anisotropic sand.

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1 32. (previously presented) The method of claim 26 wherein the at least one additional
2 measurement comprises a bulk permeability measurement of the anisotropic sand
3 and deriving the parameter of interest further comprises:

- 4 A. obtaining a family of possible distributions of volume fractions and bulk
5 irreducible water content (BVI) for the coarse and fine sand components;
6 B. determining horizontal, vertical and bulk permeability values associated
7 with said family of possible distributions; and
8 C. selecting from said family of possible distributions the one distribution
9 that has a determined bulk permeability substantially equal to the
10 measured bulk permeability.

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1 33. (previously presented) The method of claim 32 wherein said bulk permeability is
2 obtained from the group consisting of (I) NMR diffusion measurements, (II) a
3 formation testing instrument, (III) a pressure buildup test, and, (IV) a pressure
4 drawdown test.

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1 34. (previously presented) The method of claim 32 wherein determining the

2 horizontal and vertical permeability values associated with said family of
3 distributions for the coarse and fine sand components further comprises using the
4 Coates-Timur equation

$$5 \quad k = \left(\frac{\phi}{C} \right)^a \cdot \left(\frac{\phi - BVI}{BVI} \right)^b$$

6
7 where k is a permeability, ϕ is a porosity, BVI is the bound volume irreducible,
8 and a , b , and C are fitting parameters.

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1 35. (previously presented) The method of claim 32 wherein determining horizontal,
2 vertical and bulk permeability values further comprises using a relationship of the
3 form

$$4 \quad k = C \phi^a T^b$$

5 where k_e is a permeability, ϕ is a porosity and T is a NMR relaxation time, and a ,
6 b , and C are fitting parameters.

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1 36. (previously presented) The method of claim 35 wherein T is a longitudinal NMR
2 relaxation time.

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1 37. (previously presented) The method of claim 32 wherein the coarse sand portion of
2 the selected distribution is characterized by an irreducible water saturation less
3 than an irreducible water saturation of the fine grain sand portion of the selected

4 distribution.

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1 38. (previously presented) The method of claim 32 wherein the determined bulk
2 permeability is a spherical permeability related to the horizontal and vertical
3 permeability values by a relationship of the form

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$$k_{sph} = (k_h^2 k_v)^{\frac{1}{3}}$$